DOCUMENT RESUME

ED 042 885 VT 010 525

AUTHOR	Brown, William J., Jr.
TITLE	The Effect of In-Service Education and Resource Unit Components on Teacher and Student Learning. Research Series in Occupational Education No. 12.
INSTITUTION	North Carolina State Univ., Raleigh. School of Education.
SPONS AGENCY	North Carolina Research Coordinating Unit in Occupational Education, Raleigh.
PUB DATE	68
NOTE	38p.
AVAILABLE FROM	Research Coordinating Unit in Occupational Education, Division of Research, State Department of Public Instruction, Raleigh, North Carolina 27602
EDRS PRICE	EDRS Price MF-$0.25 HC-$2.00
DESCRIPTORS	Bibliographies, Evaluation, *Inservice Teacher Education, *Learning Experience, Resource Materials, *Resource Units, Statistical Analysis, *Student Improvement, Tables (Data), *Teacher Improvement

ABSTRACT

This 2 x 4 factorial experiment involved 40 high school teachers of vocational agriculture and their sophomore students. The primary purpose was to question the effectiveness of providing inservice teacher education to upgrade the subject matter competence of teachers and furnishing them with resource units. The findings were that inservice education improved the subject matter competence of teachers but did not have a significant effect of student learning. Resource units were found to be of significant value in improving the subject matter competence of the teacher, but had little influence on student learning. A bibliography and sample resource unit are appended. (BC)

THE EFFECT OF IN-SERVICE EDUCATION AND RESOURCE UNIT COMPONENTS ON TEACHER AND STUDENT LEARNING

WILLIAM J. BROWN, JR.

1968

RESEARCH SERIES IN OCCUPATIONAL EDUCATION

NORTH CAROLINA RESEARCH COORDINATING UNIT

IN

OCCUPATIONAL EDUCATION

SCHOOL OF EDUCATION
NORTH CAROLINA STATE UNIVERSITY AT RALEIGH
RALEIGH, NORTH CAROLINA

The Effect of In-Service Education and Resource Unit Components on Teacher and Student Learning

by

William J. Brown, Jr.

Research Series in Occupational Education No. 12
A report of a doctoral thesis conducted by Dr. William J. Brown, Jr., at the Pennsylvania State University, University Park, Pennsylvania. Publication and dissemination of the research findings are in cooperation with the North Carolina Research Coordinating Unit in Occupational Education

FOREWORD

The North Carolina Research Coordinating Unit in Occupational Education is pleased to have the opportunity of disseminating this report of a recent study by Dr. William J. Brown, Jr., Assistant Director, North Carolina Research Coordinating Unit in Occupational Education, North Carolina State University at Raleigh.

This publication and others to follow are a result of the partial fulfillment of the commitment of the North Carolina Research Coordinating Unit to:

(a) Stimulate research in occupational education.

(b) Identify problems for research.

(c) Develop a system by which national, state, and local data may be organized and made available.

(d) Maintain communication between people who are working in occupational education and research workers.

(e) Assist in conducting training programs on activities involved in the research-action continuum.

(f) Provide consultant services in state, local, and area research developmental activities.

TABLE OF CONTENTS

LIST OF TABLES

The Effect of In-Service Education and Resource Unit Components on Teacher and Student Learning

ABSTRACT

The effects of providing in-service teacher education and furnishing teachers with curriculum materials were investigated in a 2 X 4 factorial experiment involving forty high school teachers of vocational agriculture and their sophomore students. The study questioned the effectiveness of providing in-service teacher education classes to improve the subject matter competence of teachers. Another aspect of the study investigated the effect of furnishing teachers with resource units developed as a topical outline, a guide for teaching the unit, or a subject matter reference for the unit. The findings indicated that in-service teacher education improved the subject matter competence of teachers but had no significant effect upon their instructional competence as measured by subsequent student learning. The findings also indicated that furnishing teachers with resource units containing subject matter was of significant value in improving the teacher's subject matter competence as he taught the unit of instruction. However, student learning was not significantly affected by the resource unit components which were furnished teachers.

INTRODUCTION

Subject matter in agriculture soon becomes obsolete because of the rapidity of technological developments. As a result, most teacher education departments recognize the need for providing continuing in-service education in order to maintain and improve the instructional competence of teachers in specialized subject matter fields. Most patterns of

In-service education include courses in subject matter specialities. Some in-service education programs include the development and dissemination of resource units to aid teachers in their instructional planning. In many cases, the resource units furnished teachers provide only a suggested outline of the topics to be included in the unit of instruction. Other resource units provide a suggested guide for teaching the unit. More fully developed resource units provide the teacher with instructional guides and subject matter handbooks. Complete resource units with subject matter are provided less frequently, in part, because additional time and resources are required for their preparation. Since more resources are needed to prepare complete resource units, the relative effectiveness of each component in a resource unit must be determined so that resources for the development of curriculum materials can be more wisely allotted.

Background of the Study

Learning is assumed to be enhanced by in-service teacher education. Indeed, the data from a study of in-service education by Mork (14) showed that there was a significant difference in student learning which could be contributed to in-service education efforts. Other studies by Anderson (1) and Barr (3), however, cast doubt on whether in-service education actually makes any measurable difference in student learning. Thus, research on in-service education has been rather inconclusive partially because results of similar studies differ and partially because the different types of in-service education make it rather difficult to generalize about the effect of in-service education per se.

The organization of learning activities into units of instruction also has a long history in education. In fact, the value of furnishing

teachers with resource units has been proclaimed by educators and tested by research. Goodman (10), Saylor (15), Inlow (11), and Burton (5) provide a theoretical basis for developing resource units by suggesting that teachers can be aided in developing more effective instructional situations through the preparation and dissemination of resource units. Teachers are cautioned to use the resource units as guides for teaching rather than as prescriptions for learning.

Studies by Shontz (16) and Drawbaugh (9) supported the theoretical basis for furnishing resource units when they found that more student learning took place when teachers were provided with a complete resource unit containing suggested teacher preparations and subject matter handbooks for the teachers and students. The control group in this study were teachers who taught without the aid of the resource units. Further exploration, however, is needed to determine which of the resource unit components were most valuable to student learning.

Definition of Terms

The underlined terms are defined as follows:

The inservice education course refers to the learning activities organized for teachers in an off-campus course in dairy cattle nutrition. The course consisted of six weekly two and one-half hour classes.

A unit of instruction refers to a psychologically sound sequence of teaching-learning activities based on important problem areas of study and involving significant learning experiences. The unit of instruction in this study was dairy cattle nutrition.

A resource unit refers to written materials which include an outline of the course content, the teaching-learning activities for the unit, and

the subject matter for the unit. A resource unit serves as an aid for teachers in teaching a unit of instruction.

Resource unit components refer to the parts of a resource unit which represent different levels and types of instructional aid for teachers. The Course Outline, Teacher's Unit Plan, and Student Handbook were the three resource unit components.

The Course Outline refers to the resource unit component which identified and sequenced the content of the unit with a simple outline of each problem area. It included a list of suggested references for the unit and suggested time allotments for each problem area.

The Teacher's Unit Plan refers to the resource unit component with suggested teaching-learning activities for the unit of instruction. It included: a suggested list of teaching-learning resources for the unit and suggested student learning objectives, advance teacher preparation, technical information sources, student learning activities, and visual aids for each problem area.

The Student Handbook refers to the resource unit component which contains the subject matter necessary for teaching each problem area in the unit of instruction.

Specific Statement of the Problem

This study investigated the effectiveness of in-service education classes in increasing the subject matter competence of teachers and the subsequent effect of in-service education on student learning. In addition, the study tested the effect of furnishing teachers with various combinations of resource unit components. The resource unit components were: (1) a Course Outline which outlined the content in the unit of instruction, (2) a Teacher's Unit Plan which listed suggested preparations for teaching the

unit, and (3) a Student Handbook which presented relevant subject matter organized as a unit.

Hypotheses

The following major hypotheses were tested:

1. There is no significant difference in the cognitive knowledge of teachers who attend an in-service education course in dairy cattle nutrition and those who do not attend as measured by an achievement test administered:
    a. After the in-service education course.
    b. Immediately after teaching a similar unit to high school sophomores.
2. The cognitive learning of teachers in an in-service education course in dairy cattle nutrition has no significant effect on the subsequent learning of high school sophomores who were taught a similar unit as measured by an achievement test administered following the unit in dairy cattle nutrition.
3. The resource unit components used by teachers in teaching a dairy cattle nutrition unit to high school sophomores have no significant effect on the cognitive knowledge of teachers as measured by an achievement test administered following the unit.

    Corollary a

    The resource unit components used in teaching high school classes have no significant effect on the subsequent cognitive knowledge of teachers as measured by an achievement test, when teachers attend an in-service education course before teaching the unit.

Corollary b

The resource unit components used in teaching high school classes have no significant effect on the subsequent cognitive knowledge of teachers as measured by an achievement test, when teachers do not attend an in-service education course before teaching the unit.

4. The resource unit components used by teachers in teaching a dairy cattle nutrition unit to high school sophomores have no significant effect on the cognitive knowledge of students as measured by an achievement test administered following the unit.

Corollary a

The resource unit components used in teaching high school classes have no significant effect on the cognitive knowledge of students as measured by an achievement test, when teachers attend an in-service education course before teaching the unit.

Corollary b

The resource unit components used in teaching high school classes have no significant effect on the cognitive knowledge of students as measured by an achievement test, when teachers do not attend an in-service education course before teaching the unit.

Procedure

The study included developmental and experimental phases. In the developmental phase, a resource unit was written and two testing instruments were prepared. The resource unit included the following components: (1) a Course Outline, (2) a Teacher's Unit Plan, and (3) a Student Handbook. The Course Outline included the subject matter headings for each problem

area and a list of suggested references. The Teacher's Unit Plan included suggested objectives, teaching aids, references, preparations for teaching the unit, and student learning activities. The Student Handbook provided a source of important subject matter for the dairy cattle nutrition unit.

Two separate multiple-choice tests were developed and used in measuring the learning of teachers and students. The tests were developed by listing the important principles, concepts, and facts included in the unit. Multiple-choice questions which were representative of these principles, concepts and facts were constructed. The first version of the teacher test was field-tested with teachers in in-service courses. Each item was reviewed by educational and subject matter specialists for face and content validity. Questionable test items were discarded. A fifty item test was selected to measure teaching learning. The student test was developed by field-testing the teacher test with high school sophomores and by running an item analysis. Test items with low evaluations were either revised or deleted.

After developing the resource unit and the multiple-choice tests, the experimental phase of the study was initiated. Twenty of the teachers selected for the study had attended the in-service education course in dairy cattle nutrition; the other half had not. The twenty teachers in the in-service education treatment were randomly selected from teachers who had attended the in-service education course and volunteered to participate in the study.

The in-service education course had not been taught at two other off-campus centers. Dairying was, however, an important enterprise in each

of these areas and the in-service education course was scheduled for these areas during the summer. Teachers in these two areas were asked if they would participate in the experiment. Twenty teachers were randomly selected from the group that volunteered to participate. These twenty teachers comprised the No In-Service Education treatment group and were assumed to be similar to the experimental group with regard to interest in participating in the experiment. Pretests were given to determine if there was a significant difference between the two groups in their knowledge of the subject matter. Each teacher's undergraduate grade point average in college was also secured as a general measure of academic ability. Both pretest and grade point average were used in the analysis of data to equate for any initial differences in the two groups.

To complete the 2 X 4 factorial design, teachers in the In-Service Education and No In-Service Education treatment groups were randomly assigned to one of four resource unit component treatment groups. The four resource unit component groups were: (1) Course Outline only, (2) Course Outline and Teacher's Unit Plan, (3) Course Outline and Student Handbook, and (4) Course Outline, Teacher's Unit Plan, and Student Handbook.

Teachers in the In-Service Education treatment group were pretested before the course, tested after the course, and retested later after they had taught a similar unit to high school sophomores. Teachers in the No In-Service Education treatment group were pretested before they taught the unit and tested after teaching the unit.

Student learning was measured by pretesting at the start of the unit and testing at the conclusion of the unit. Intelligence quotient scores and average numerical grade in ninth grade subjects were used as measures

of student aptitude and academic achievement, respectively.

Differences in test scores between the in-service treatment groups and among the resource unit component treatment groups were tested for significance by analysis of covariance. Multiple regression analysis was used to determine the most effective covariates.

Limitations of the Study

The study is limited in that it is not generalizable to broad groups of teachers in other fields as well as to groups of teachers who chose not to participate in educational experiments and in-service education programs. Although these problems are inherent in field research, replications of the study in other areas could increase the generalizability of the collective research efforts.

FINDINGS AND DISCUSSION

The test scores of teachers and students were adjusted by covariance for measurable variables which were not controlled by the experiment design. Table I shows the correlation matrix of scores on teachers and students. After multiple regression analysis of the data in Table I, the teacher pretest and undergraduate college grade point average were selected as the two most effective covariates to use in adjusting the teachers' retest scores and the student pretest and IQ were selected as the two most effective covariates to use in adjusting the student test scores.

Table 1. Correlation Matrix of Teacher and Student Scores.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_2	.807						
X_3	.728	.766					
X_4	.428	.269	.457				
X_5	.394	.355	.460	.076			
X_6	.399	.232	.321	.019	.615		
X_7	.172	.086	.203	.089	.454	.392	
X_8	.003	.085	.037	.075	.056	.014	.115

X_1 - Teachers' Pretest

X_2 - Teachers' Test

X_3 - Teachers' Retest

X_4 - Teachers' Grade Point Average

X_5 - Student Test

X_6 - Student Pretest

X_7 - Student Intelligence Quotient

X_8 - Student Grade Point Average

r value of .383 significant at .05 level with 38 d.f.

The findings shown in Table 2 indicate that the successful completion of the in-service education course in dairy cattle nutrition significantly increased the subject matter competence of teachers. The difference in subject matter knowledge between the in-service education treatment groups

was significant after the in-service education course and after both groups taught a similar unit in dairy cattle nutrition to their high school sophomores. Teachers in the treatment group that did not attend the in-service education course were able to improve their subject matter competence by teaching the unit with the resource unit components, however, the learning which occurred while teaching the unit was not enough to compensate for missing the in-service education course.

Table 2. Teacher test scores and retest scores, adjusted for pretest and college grade point average, by in-service education treatment.

		Mean Scores of Teachers				
Treatment	N	Grade Point Average	Pretest[a]	Test[b]	Retest	Adjusted Retest[c]
In-Service Education	20	2.69	29.2	34.3	36.8	36.1
No In-Service Education	20	2.65	27.5		31.6	32.3

[a]Pretest scores not significantly different at the .05 level

[b]Test scores of In-Service Education group significantly different from the pretest scores of the No In-Service Education group at the .01 level by analysis of variance

[c]Retest scores adjusted for grade point average and pretest were significantly different at the .01 level by covariance

Table 3 indicates that there were no significant differences in student learning which could be attributed to the teacher's in-service education experience during the experiment.

Table 3. Student test scores, adjusted for pretest and IQ, by in-service teacher education treatment.

Treatment	N (Schools)	Mean Scores of Students			
		Before Unit		After Unit	
		IQ	Pretest	Test	Adjusted Test[a]
In-Service Education	20	97.7	17.2	21.9	22.4
No In-Service Education	20	99.2	18.2	22.3	21.9

[a]No significant difference at the .05 level by covariance between adjusted test scores

The absence of an effect of in-service teacher education on student learning may be attributed to other intervening variables such as the possibility that teachers may have monitored the suggested content for the unit of instruction and emphasized the more familiar subject matter at the expense of new subject matter learned during the in-service education course.

The magnitude of the differences in subject matter knowledge between the two treatment groups may also be a contributing factor to an absence of significant differences in student learning. According to the pretest scores, teachers in the No In-Service Education treatment group had considerable

competence in dairy cattle nutrition even without further schooling. Thus, the difference in subject matter knowledge of teachers after the in-service education course may not have been large enough to make an appreciable difference in student learning.

The type of resource unit components used by teachers as instructional aids significantly affected their learning. Table 4 shows that teachers who received a Course Outline and a Student Handbook scored significantly higher after teaching the unit to high school sophomores than teachers who were furnished only the Course Outline. No other differences were significant.

Table 4. Teacher test scores, adjusted for college grade point average and pretest, by resource unit components furnished teachers.

Resource Unit Component Furnished Teachers	n	Mean Scores of Teachers			
		Before Teaching Unit		After Teaching Unit	
		Grade Point Average	Pretest	Test	Adjusted Test[a]
Course Outline	10	2.52	31.1	32.0	32.3
Course Outline and Teacher's Unit Plan	10	2.86	32.5	35.2	33.5
Course Outline and Student Handbook	10	2.75	30.2	36.3	36.5
Course Outline, Teacher's Unit Plan, and Student Handbook	10	2.54	29.6	33.3	34.5

[a]Course Outline and Student Handbook treatment significantly higher at .05 level by covariance than the Course Outline treatment

Teacher test scores by in-service education treatment and by resource unit component treatment are shown in Table 5.

Table 5. Teacher test scores, adjusted for college grade point average and pretest by in-service education treatment and resource unit components furnished teachers.

Resource Unit Component Furnished Teachers	n	Mean Scores of Teachers			
		Before Teaching Unit		After Teaching Unit	
		Grade Point Average	Pretest	Test	Adjusted Test
Teachers Who Attended In-Service Education Course					
Course Outline	5	2.54	36.6	37.2	36.6
Course Outline and Teacher's Unit Plan	5	2.90	33.6	37.2	36.6
Course Outline and Student Handbook	5	2.72	33.4	38.0	38.3
Course Outline, Teacher's Unit Plan, and Student Handbook	5	2.58	33.2	34.6	35.5
Teachers Who Did Not Attend In-Service Education Course					
Course Outline	5	2.50	25.6	26.8	28.6
Course Outline and Teacher's Unit Plan	5	2.82	31.4	33.2	29.6
Course Outline and Student Handbook	5	2.78	27.0	34.6	34.9[a]
Course Outline, Teacher's Unit Plan, and Student Handbook	5	2.50	26.0	32.0	33.5

[a]Adjusted test scores for the Course Outline and Student Handbook treatment significantly higher at the .05 level by covariance than the Course Outline treatment and the Course Outline and Teacher's Unit Plan treatment in the No In-Service Education group

Although the interaction between in-service education and resource unit components was not significant at the .05 level, the use of resource unit components with subject matter had more effect on those teachers who did not attend the in-service education course. Evidently providing teachers with resource units containing subject matter can effectively improve their subject matter competence. In situations where in-service education courses in subject matter specialities cannot be offered as rapidly as desired, an alternate form of in-service education may be the development and dissemination of resource units which contain subject matter.

Furnishing teachers with different combinations of resource unit components did not significantly affect the learning of students as shown by Table 6. No singlificant interaction was found between providing teachers with in-service education and their ability to utilize resource unit components effectively in promoting student learning.

Table 6. Student test scores, adjusted for IQ and pretest, by resource unit component treatment.

Resource Unit Components Furnished Teachers	n (Schools)	Mean Scores of Students			
		Before Unit		After Unit	
		IQ	Pretest	Test	Adjusted Test[a]
Course Outline	10	98.8	17.7	22.2	22.1
Course Outline and Teacher's Unit Plan	10	99.1	18.2	21.0	20.5
Course Outline and Student Handbook	10	99.5	18.4	23.4	22.6
Course Outline, Teacher's Unit Plan, and Student Handbook	10	96.5	16.6	21.7	23.1

[a]No singificant differences at the .05 level by covariance

CONCLUSIONS

1. Teachers who attended an in-service education course were more competent in dairy cattle nutrition subject matter than a control group who did not attend the course.
2. Teachers who attended the in-service education course remained more competent in knowledge of dairy cattle nutrition subject matter after teaching a unit on dairy cattle nutrition to high school sophomores than the control group of teachers who taught the unit to high school students but did not attend the in-service education course.
3. Increasing the cognitive subject matter knowledge of teachers in an in-service education course on dairy cattle nutrition did not affect the subsequent learning of their high school students when compared to a control group of students taught by teachers who did not attend the course.
4. The cognitive knowledge of teachers was affected by the resource unit components which they used in teaching the unit to their high school students. Teachers who used the Course Outline and Student Handbook in teaching the unit were higher in subject matter competence than teachers using the Course Outline alone.
5. The type of resource unit component furnished teachers did not affect the learning of their students.

IMPLICATIONS

In-service education courses are effective in increasing the subject matter competence of teachers, but, teacher educators should be aware that increased subject matter competence does not necessarily result in increased student learning. Likewise, furnishing teachers with resource units

increased teacher competence but did not affect student learning. In evaluating the contribution of in-service education and resource units to learning, it would be wise to consider the many intervening variables which may have confounded the learning environment making it difficult to detect differences in student learning. An obvious factor influencing student learning was that teachers in this study had considerable competence in dairy cattle nutrition regardless of their in-service education experience.

A corollary finding indicated that the Student Handbook containing subject matter organized as a unit of instruction contributed significantly to in-service teacher education. The study indicated that the Student Handbook was more effective in improving teacher subject matter knowledge when used alone rather than in combination with the Teacher's Unit Plan. It may be that teachers reviewed the subject matter handbooks more thoroughly if they were not provided with suggested teaching activities and learned more as a result of developing their own teaching plans.

Although student learning was not significantly affected by the different combinations of resource unit components furnished to teachers, student learning tended to be higher when teachers used the Student Handbook either with or without a Teacher's Unit Plan. Earlier studies by Drawbaugh (9) and Shontz (16) tested the effectiveness of resource units in relatively new areas of instruction. Their findings indicated that students learned more when taught by teachers who used comprehensive resource units than when taught by a control group of teachers using their own instructional plans. In the Drawbaugh and Shontz studies, however, students did not make significant increases in subject matter knowledge from pretest to test when taught by a control group of teachers who used

their own instructional plans. In contrast, students in this study increased singlificantly in subject matter knowledge from pretest to test even when their teachers were furnished a minimum amount of instructional aid. It seems that teachers who are sufficiently oriented to the content of a familiar unit can teach a unit with a minimum amount of instructional aid and still increase student learning. Furnishing teachers with resource units containing subject matter may be most effective in those instances where the unit is relatively unfamiliar to the teacher.

RECOMMENDATIONS

From the findings of the study, it is recommended:

1. That in-service education courses and the development and dissemination of resource units be contined as means of increasing the subject matter competence of teachers.
2. That consideration be given to providing in-service education programs which go beyond increasing the subject matter knowledge of teachers. Providing supervision as a follow-up of the in-service education may be needed to help teachers incorporate the subject matter which they learned into their instruction.
3. That instructional materials for teachers include integrated subject matter sequenced and organized for a unit of instruction.
4. That further studies be conducted testing the effect of in-service education and furnishing resource units on student learning in order to increase the generalizability of this study. These studies should be aware of the difficulties involved in the indirect measurement of the effectiveness of these variables and attempt to control more of the interacting variables affecting student learning.

BIBLIOGRAPHY

1. Anderson, Robert H. "The influence of an In-Service Improvement Program Upon Teacher Test Behavior and Classroom Program," Journal of Educational Research, 44: 205-215, November, 1950.

2. Archer, Clifford P. "In-service Education," Encyclopedia of Educational Research, pp. 702-710, 1960.

3. Barr, A. S. "Some Problems in the Measurement of Teaching Ability," Journal of Educational Research, 33: 363-365, January, 1940.

4. Bloom, Benjamin S. "Testing Cognitive Ability and Achievement," Handbook of Research on Teaching, pp. 379-397, 1963.

5. Burton, William H. The Guidance of Learning Activities, New York: Appleton-Century-Crofts, Inc., 1962.

6. _____., et al. Education for Effective Thinking. New York: Appleton-Century-Crofts, Inc., 1960.

7. Caswell, Hollis L. and Campbell, Doak S. Readings in Curriculum Development, New York: American Book Company, 1937.

8. Cook, Walter W., et al. "Curriculum Research," Review of Educational Research, 26: 224-240, June, 1956.

9. Drawbaugh, Charles Calvin. "A Teaching Experiment in the Use of Greenhouse Facilities in Vocational Agriculture." Unpublished Doctor's thesis, The Pennsylvania State University, 1963.

10. Goodman, Samuel M. Curriculum Implications of Armed Services Educational Programs. Washington: American Council on Education, 1947.

11. Inlow, Gail M. Maturity in High School Teaching. New York: Prentice-Hall, Inc. 1963.

12. Kearney, Nolan C. and Cook, Walter W. "Curriculum," Encyclopedia of Educational Research, pp. 358-364.

13. Mitzel, Harold E. "Teacher Effectiveness," Encyclopedia of Educational Research, pp. 1481-1486, 1960.

14. Mork, Gordon A. "Effects of an In-Service Teacher Training Program on Pupil Outcomes in Fifth and Sixth Grade Science." Unpublished Doctor's thesis, University of Minnesota, 1953, Dissertation Abstracts, XIII, 522.

15. Saylor, John Galen and Alexander, William M. Curriculum Planning for Modern Schools. New York: Holt, Rinehart, and Winston, Inc., 1966.

16. Shontz, David F. "An Experiment in Teaching Agricultural Occupations Information to High School Students," Unpublished Doctor's thesis, The Pennsylvania State University, 1963.

APPENDIX A

(Sample Pages of the Course Outline)

DAIRY CATTLE NUTRITION
COURSE OUTLINE

Class Time: 18 clock hours

PROBLEM AREA 1
Classifying Feeds
(Suggested Class Time: 2 hrs.)

I. Types of Feeds
   A. Pasture or soiling crops
   B. Forages (dry and preserved)
   C. Concentrates

II. Chemical Classifications of Feeds
   A. Water
   B. Dry Matter
   C. Mineral Matter or Ash

PROBLEM AREA 2

Digesting and Utilizing Feeds
(Suggested Class Time: 4 hrs.)

I. Definition of Digestion
II. The Digestive Tract of a Dairy Cow
III. The Digestion and Absorption of Nutrients by Dairy Cattle
IV. The Utilization of Nutrients for Body Functions

PROBLEM AREA 3

Evaluating Feeds and Formulating Feeding Programs
(Suggested Class Time: 6 hrs.)

I. Methods of Evaluating Feeds
   A. Visual estimation
   B. Date of cutting
   C. Chemical analysis
   D. Digestion trials
   E. Energy content and utilization

II. Penn State Forage Testing Service
   A. The purpose of forage testing
   B. Securing forage testing supplies
   C. Sampling procedures
   D. Processing period
   E. Forage evaluation and rating

III. Formulating a Grain Mixture

PROBLEM AREA 4

Feeding Dairy Cows
(Suggested Class Time: 6 hrs.)

I. General Feeding Practices
   A. Feeding the dry cow
   B. Feeding at calving
   C. Feeding for production
   D. Summer feeding

II. Lead Feeding
   A. Dry cow feeding
   B. Fresh cow feeding

III. Planning Feeding the Programs for the Herd
   A. Determining the amount of roughage
   B. Determining the amount and protein level of the grain mixture

REFERENCES:

BOOKS:
1. Morrison, Frank B., Feeds and Feeding, Abridged, Ninth Edition
2. Reaves, Paul M. and Henderson, H. O. Dairy Cattle Feeding and Management

BULLETINS:
1. The Pennsylvania State University, Summary of the Penn State Forage Testing Service
2. The Pennsylvania State University, How to Use the Penn State Forage Testing Service
3. The Pennsylvania State University, Penn State Grain Feeding Guide for Dairy Cows

UNPUBLISHED MIMEOGRAPHS:
1. Adams, R. S. Notes on Ruminant Nutrition as Related to Dairy Cattle
2. Adams, R. S. Notes on Hay-Crop Silage

APPENDIX B

(Sample Pages of Teacher's Unit Plan)

Dairy Cattle Nutrition - A Teacher's Unit Plan

Problem Areas	Dates To Be Taught
1. Classifying Feeds	_____
2. Understanding Digestion and Feed Utilization	_____
3. Evaluating Forages and Formulating Feed Rations	_____
4. Feeding Dairy Cattle	

SUGGESTED LIST OF TEACHING-LEARNING RESOURCES

References:

Published

1. Dairy Cattle Feeding and Management. Reaves, Paul M. and Henderson, H. O., John Wiley and Sons, Inc., New York, 1963.

2. Dairy Cattle Nutrition - A Student Resource Unit. Brown, W. J., Jr., and Love, G. M., Department of Agricultural Education, The Pennsylvania State University, University Park, Pennsylvania, 1965.

3. Feeds and Feeding, Abridged. Morrison, Frank B., The Morrison Publishing Company, Ithaca, New York, 1958.

4. How to Use the Penn State Forage Testing Service. Adams, R. S., The Pennsylvania State University, College of Agriculture, Extension Service, University Park, Pennsylvania.

5. Penn State Grain Feeding Guide for Dairy Cows. The Pennsylvania State University, College of Agriculture, Extension Service, University Park, Pennsylvania.

6. Summary of the Penn State Forage Testing Service. The Pennsylvania State University, College of Agriculture, Extension Service, University Park, Pennsylvania.

Problem Area I

Classifying Feeds

Current Situation

Feeding practices for dairy cattle have changed rapidly in recent years. For example, feeding recommendations for grain mixtures are being based on accurate evaluations of forage. Urea is being substituted for limited portions of protein in many commercial grain mixtures. Lead feeding is being used to increase milk production.

To understand and use new practices, a basic understanding of feeds and nutrition is necessary. One basic concept needed in feeding is: a knowledge of different characteristics of feeds and how feeds are classified chemically.

Student Learning Objectives

Students should learn:

1. The characteristics of pasture or green chop, dry and preserved forages, and concentrate mixtures.
2. The chemical classifications used to analyze feeds.

Advance Teacher Preparation

The technical information in this Problem Area is outlined below:

I. Types of Feeds

   A. Pasture or green chop

B. Dry and preserved forages

C. Concentrates

II. Chemical Classifications of Feeds

A. Water

B. Dry matter

C. Minerals and ash

Review the following technical information sources.

Technical Information Sources

1. Dairy Cattle Nutrition - A Student Resource Handbook. Problem Area 1.
2. Feeds and Feeding, Abridged. pp. 1-15, 48-80.
3. Dairy Cattle Feeding and Management. pp. 9-11.

While reviewing the technical information for this Problem Area, formulate key questions which will guide students toward the learning objectives. We suggest the following questions:

1. What are the nutritive characteristics of pasture, dry and preserved forages, grain mixtures, and protein supplements?
2. How are feeds classified?
3. Urea is a non-protein, nitrogenous material used as a source of protein in feeds? What are its advantages and limitations?
4. Are lignin and cellulose highly digestible? How does this relate to the decreasing percentage of total digestible nutrients in forages as they mature?

Student Learning Activities

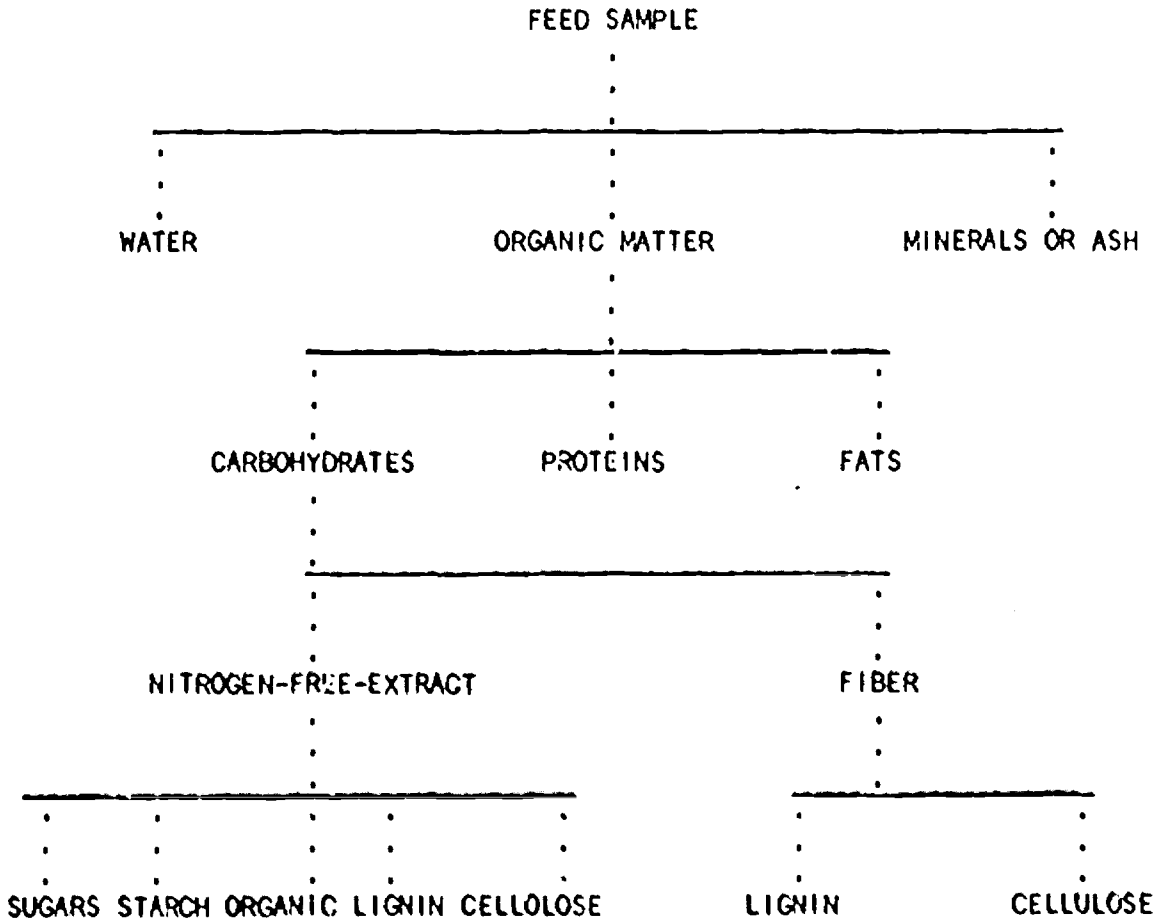
1. Research has shown that supplying dairy cows water free-choice as opposed to twice-a-day increases milk production. Discuss the methods and importance of supplying a dairy herd with adequate water. The functions of water in the body processes should be understood.
2. Soybean oil meal and corn are feeds commonly used in grain mixtures. They contain different percentages of protein and TDN and therefore are included in the grain mixture for different reasons. Using the feeding standards in Morrison's Feeds and Feeding, the students should develop a graph listing the percentages of TDN and protein in corn and soybean oil meal. Have students list other major feed sources which are similar to corn and soybean oil meal. The palatability and cost of feed sources should be considered.
3. The percentage of substances in a feed changes with the plant's stage of maturity. Corn silage stores large quantities of carbohydrates as the corn ears mature. It therefore increases in percentage of total digestible nutrients with maturity. Hay, however, increases rapidly in percentage of lignin and cellulose after reaching the "bud" stage. This lowers the percentage of total digestible nutrients in more mature hay. Students should use these facts in evaluating the recommended time for cutting the harvesting forages.

Visual Aids

The following diagram has been developed for teaching this Problem Area. Reproduce visual aids in the form and quanity needed for your classes. We suggest overlays for the overhead projector.

MAKE-UP OF FEEDS

LEARNING OBJECTIVE: WHAT IS THE MAKE-UP OF FEEDS?



APPENDIX C

(Sample Pages of Student Handbook)

Dairy Cattle Nutrition - A Student Handbook

Problem Area I

Classifying Feeds

Along with approved breeding practices and producing quality milk, feeding dairy cows may be listed as a major management function. Much variation exists in the value and quality of feeds as well as in the ability of dairymen to feed their herds. The fact that many dairy experts insist that most dairy cows are fed at a level below their capacity to produce is a serious accusation which should not be taken lightly even by the best dairymen. If what they say is true, it means that most dairymen can improve their incomes by improving their feeding practices. Therefore, dairymen need to study and know more about the science of dairy cattle feeding. Proper feeding of dairy cows involves more than providing feed. Feed must supply total digestible nutrients and digestible protein at rates which meet the cow's nutritional needs. In addition, the feed sources must be selected on a least-cost basis if the dairyman is to earn a reasonable profit.

Feeds may be classified by type and by chemical classifications.

Types of Feed

Agronomically, feeds may be classified as:

1. soiling crops, such as pasture and forages which are harvested and fed green.
2. dry and preserved forages, including hay, silage and haylage.

3. concentrates and supplements, such as corn, soybean oil meal and other crops and by-products supplying relatively large amount of digestible nutrients. Grain mixtures usually contain large amounts of concentrates mixed with lesser amounts of supplements, such as, soybean oil meal.

Classifying feeds by type is useful when describing feeds and their characteristics. It does not aid in the evaluation of the quality of feeds. For example, the variation in water content of such feeds as green chop, hay, silage and corn makes it difficult for dairymen to compare these feeds. Consequently, a chemical classification has been developed.

Chemically Classifying Feeds

A chemical system frequently used for classifying the components of plants and animals is shown in Figures 1-3 which follow. This system is more useful in arriving at the relative value of feeds. On the following pages is a review of the chemical make-up of feeds. This review points out the importance of each of the chemical components of feed.

Water

Water constitutes roughly 70 to 80 percent of all living plants and animals and as much as 8 to 15 percent of dry feeds such as corn. Consequently, the value of a feed varies widely in relation to its moisture content.

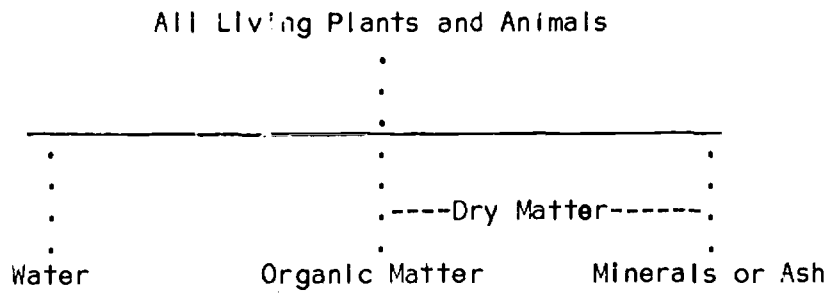


FIGURE 1. All Living Plants and Animals are Composed of Water, Organic Matter and Mineral Ash. Water may be removed by drying at 212°F. After the water is removed, burning will destroy organic matter. That which remains is ash.

Because the bodies of dairy cows and the milk they produce are composed largely of water, they need an abundant and convenient supply of water. A mature cow will drink from 18 to 37 gallons of water depending on the temperature. Studies have shown "... that cows watered twice daily will produce one percent more milk than cows watered once daily. Cows given free access to water will produce an additional 2.8 percent more milk than when watered twice daily."[1]

Water performs at least four important functions in plants and animals. It helps them to:

1. hold their shape
2. control their temperature
3. absorb and translocate nutrients
4. bring about chemical changes during digestion

Organic Matter

Water can be removed from a sample of plant or animal tissue by drying the sample at 212°F. until it ceases to lose weight. That which

[1]Profitable Dairy Management, 11th Edition, Porter, G. H., et al., The Beacon Milling Company, Cayuga, New York, 1961.

remains is dry matter. Dry matter is composed of organic matter and mineral matter or ash as Figure 1 illustrates. When a sample of dry matter is burned, organic matter is oxidized and escapes as a gas. The remainder is mineral matter or ash. Organic matter may be further broken down as shown in Figure 2.

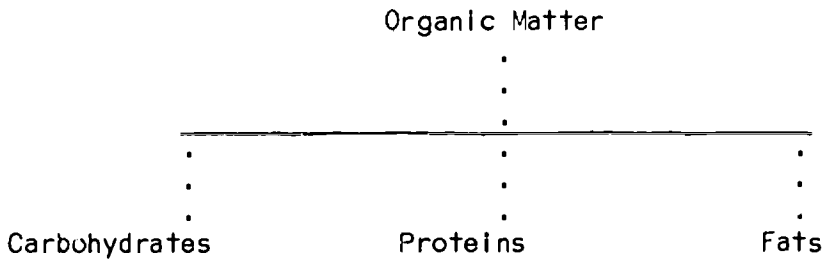


FIGURE 2. All organic matter may be roughly classified as carbohydrates, proteins or fats.

Carbohydrates

Carbohydrates are very important in dairy cattle feeding. They make up about 75 percent of all the dry matter in plants. For animals they are the primary source of heat and energy. Sugars, starches, cellulose and lignin are all broadly classified as carbohydrates, although neither cellulose nor lignin have the same chemical make-up as true carbohydrates. Usually, in the laboratory anslysis of feeds, carbohydrates are broken down into fiber, also referred to as crude fiber, and nitrogen-free-extract. Here again, the system of classification is somewhat inaccurate. As can be seen in Figure 3, part of the lignin which is a substance of considerably less feeding value when compared with sugars and starches, is classified with the nitrogen-free-extract, while another part is classified in the fiber category. If a feed usually contains considerably fiber, such as forages, more lignin and cellulose is likely to be classified in the nitrogen-free-extract category. Therefore, it is helpful to know the relative

fiber content of feeds. Generally speaking, the higher the fiber content, the lower the TDN value of the feed when comparisons are made on a dry matter basis.

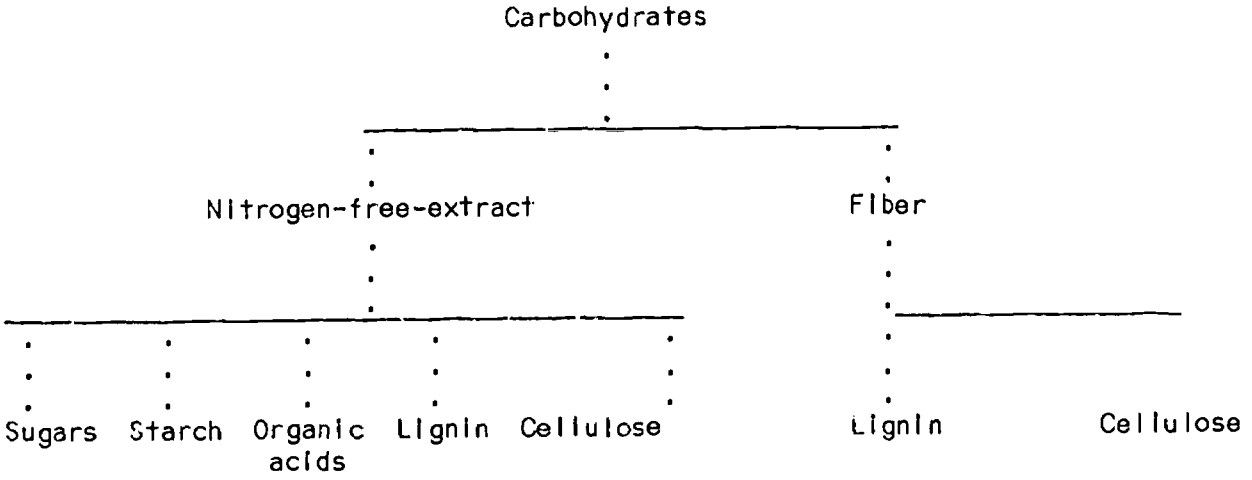


FIGURE 3. Carbohydrates are divided into two chemical classifications, nitrogen-free-extract and fiber, in the usual analysis of feeds. This classification inaccurately puts some low feed value substances like cellulose and lignin in with higher feed value substances like sugar and starch.

Sugars

Sugars are often called the portable building materials of plants. They are all soluble in water and therefore, readily available. The simplest sugars contain either five carbon ($C_5 H_{10} O_5$), or six carbon ($C_6 H_{12} O_6$) atoms. The former are called pentoses while the latter are called hexoses. Examples of some important hexose sugars are:

1. glucose
2. fructose
3. galactose

Glucose circulates throughout the body of the cow in the blood being absorbed by the cells in tissues as needed.

Starches

In nature, plants have the capacity to formulate more complex carbohydrates by combining several molecules of sugar with the elimination of water. These are called starches. Animals convert starches to sugars with enzymes and gastric juices. Most plants store their food reserves i the form of starch.